NASA'S INTEGRATED SPACE TRANSPORTATION PLAN

Harry Cikanek
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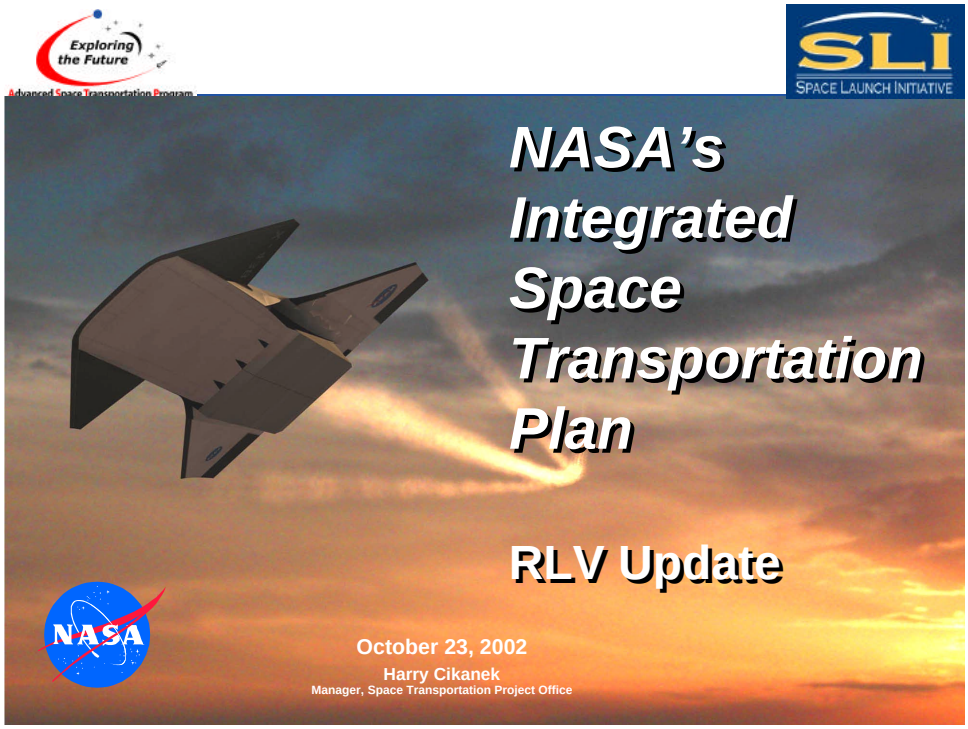
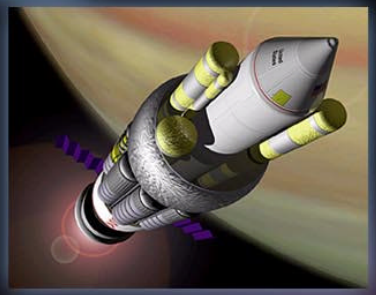


Integrated Space Transportation Plan: A National Plan

Space Shuttle Safety Upgrades

Space Launch Initiative

- 2nd Generation RLV Risk Reduction
- NASA Unique Systems
- Alternate Access to the ISS



3rd Generation RLV and In-Space Research and Technology

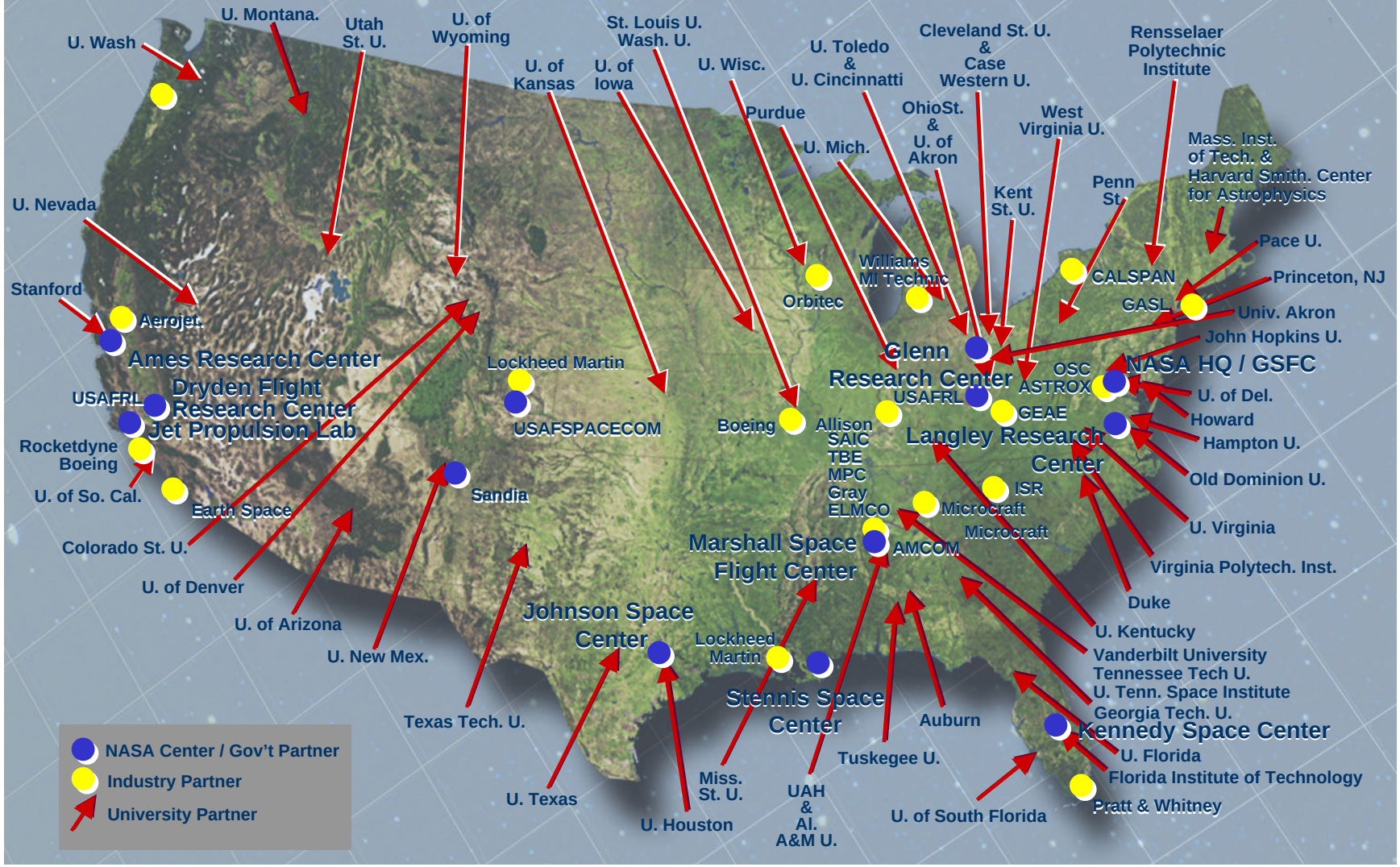
NASA's Long-Term Investment Strategy to Increase the Safety, Reliability and Reduce the Cost of Space Access

Space Transportation - A National Team Effort

Exploring the Future

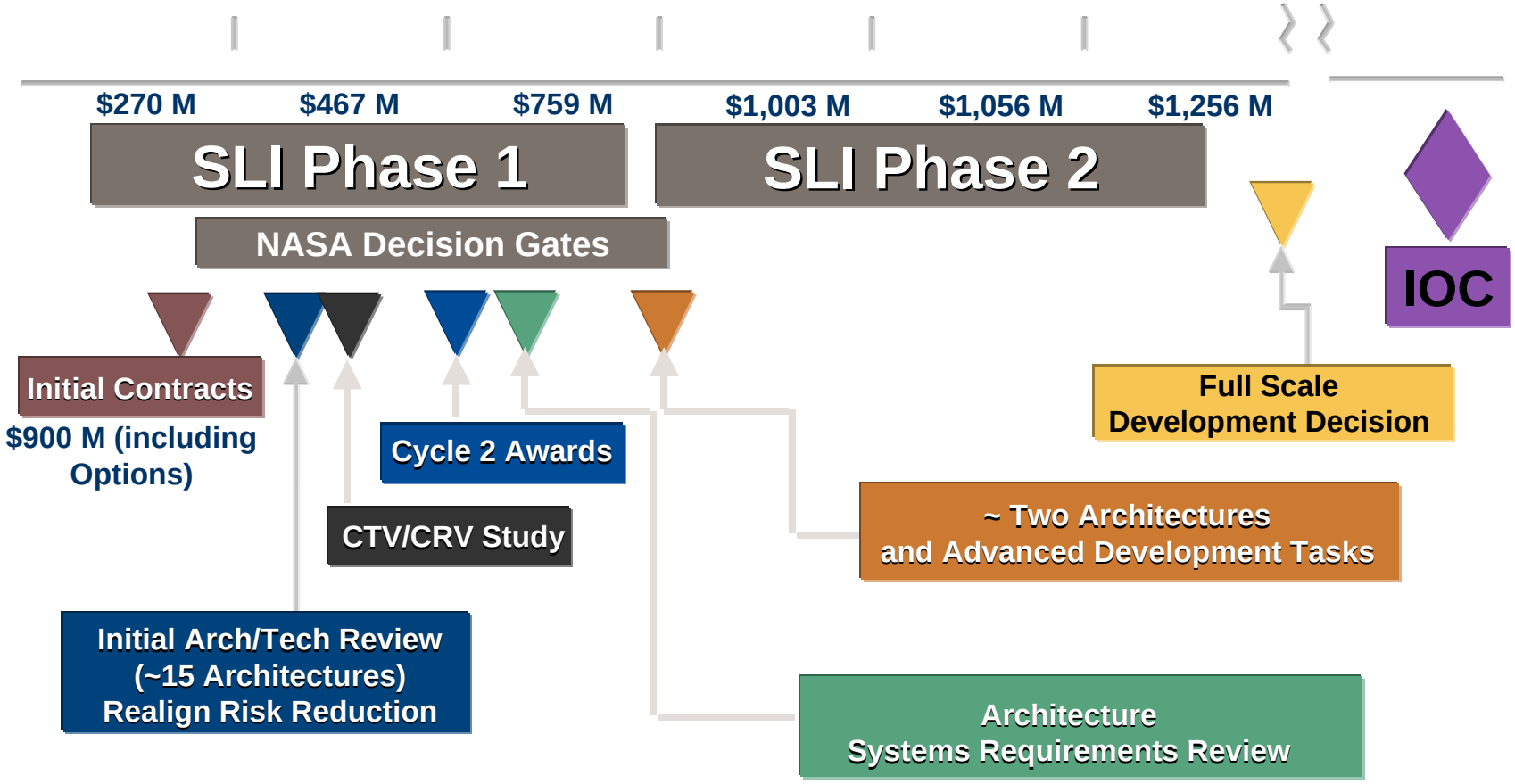
Advanced Space Transportation Program

Developing Revolutionary Technologies to Explore the Future

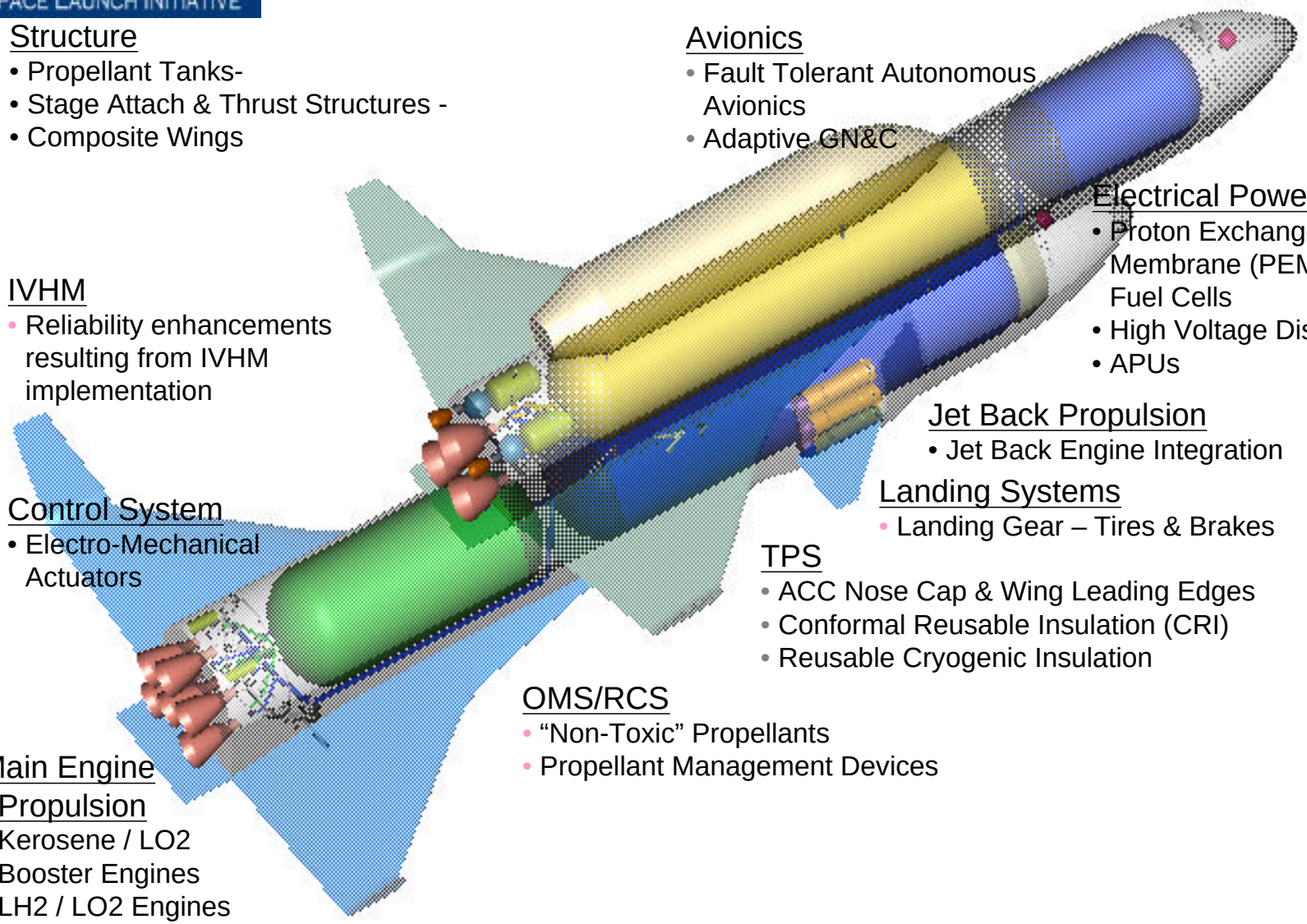


SLI Program Schedule

- **Mid-Decade: Full-Scale Development Decision**
- Early Next Decade: Initial Operational Capability



Technology Linked To Architecture Needs



Structure
- Propellant Tanks-
- Stage Attach & Thrust Structures -
- Composite Wings

Avionics
- Fault Tolerant Autonomous Avionics
- Adaptive GN&C

Electrical Power
- Proton Exchange Membrane (PEM) Fuel Cells
- High Voltage Dist.
- APUs

IVHM
- Reliability enhancements resulting from IVHM implementation

Jet Back Propulsion
- Jet Back Engine Integration

Landing Systems
- Landing Gear – Tires & Brakes

Control System
- Electro-Mechanical Actuators

TPS
- ACC Nose Cap & Wing Leading Edges
- Conformal Reusable Insulation (CRI)
- Reusable Cryogenic Insulation

OMS/RCS
- “Non-Toxic” Propellants
- Propellant Management Devices

Main Engine Propulsion
- Kerosene / LO2 Booster Engines
- LH2 / LO2 Engines

Exploring the Future
Advanced Space Transportation Program

Air Breathing Hypersonics
Applications and Benefits

Hypersonic Missiles

Near-Term
This Decade

Hypersonic Cruiser

Mid-Term
Next Decade

Reusable Launch Vehicles

Long-Term
Decade after Next

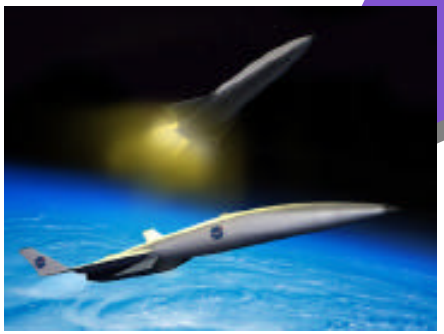
Exploring the Future
Advanced Space Transportation Program

Large 3rd Generation RLV Design Space

Horizontal Take-Off SSTO

Vertical Take-Off SSTO

- Over 30 concepts (primarily using airbreathing propulsion)
- Selected by aerospace community (NASA, DOD, Industry)
- Probabilistic systems analysis for key technologies



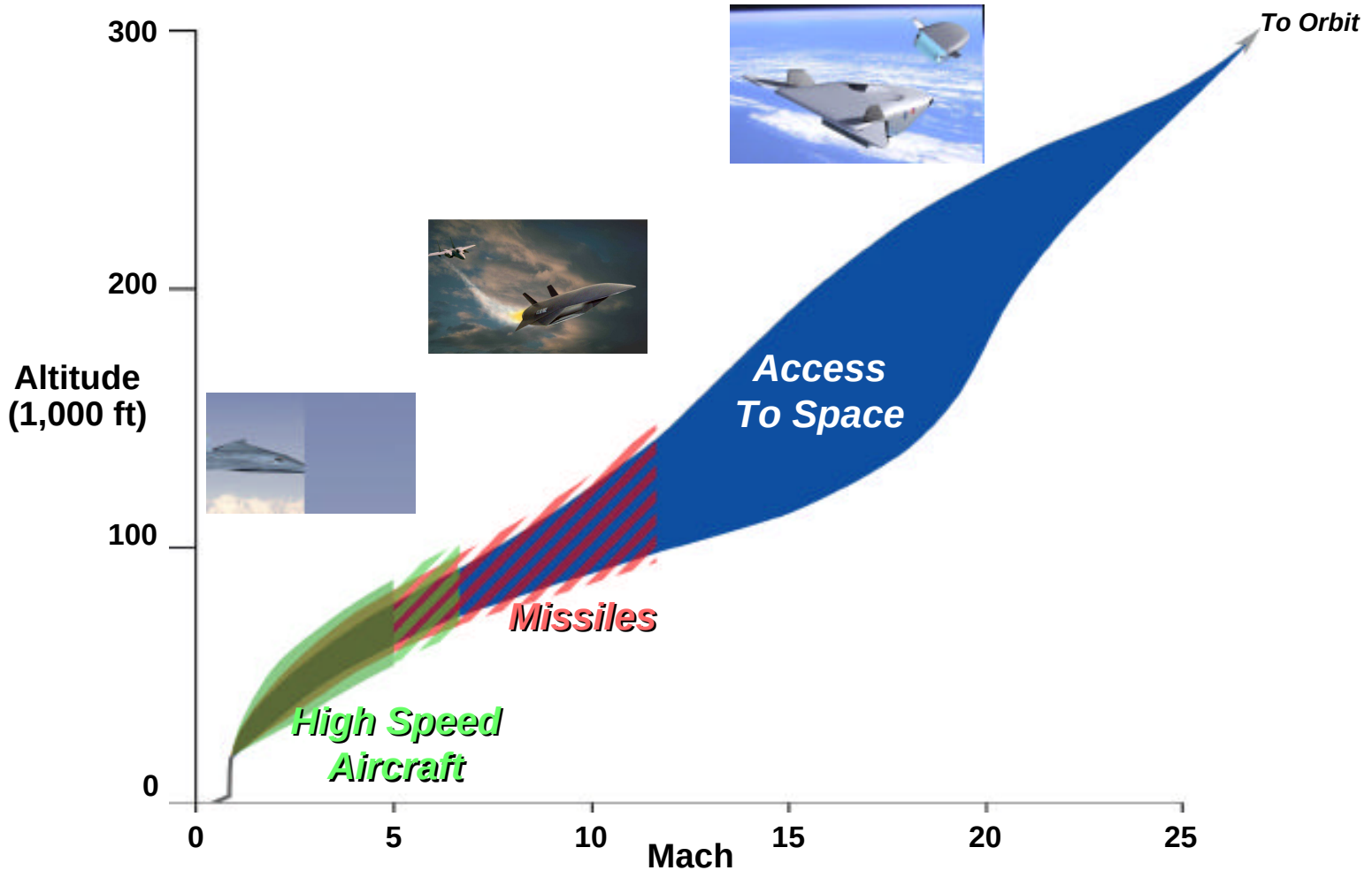
Horizontal Take-Off TSTO

Vertical Take-Off TSTO

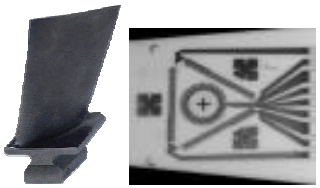
Exploring the Future
Advanced Space Transportation Program

Representative Flight Corridors

Air Breathing Hypersonic Flight



Technologies and Systems Analysis

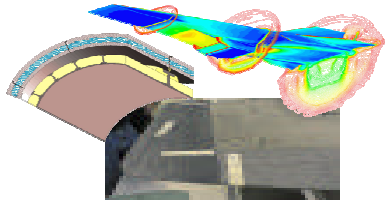


Propulsion Research and Technology Project

- Rotating Components and Seals
- Flowpath Components
- Engineering Capabilities

Systems Analysis Project

- Requirements
- Synthesis
- Analysis and Assessment



Airframe Research and Technology Project

- Integrated Airframe Design
- Integrated Thermal Structures
- Thermal Protection
- Aerothermodynamics
- Propulsion Airframe Integration

Pursing Enabling Propulsion and Airframe Technologies

Exploring the Future
Advanced Space Transportation Program

Propulsion Ground Demonstrations

Rocket Based Combined Cycle Ground Demonstration (ISTAR)

- Demonstration of a Rocket Based Combined Cycle Engine ***System***
- Testing in 2006-8
- Aerojet, Rocketdyne, P&W Consortium (RBC^3)

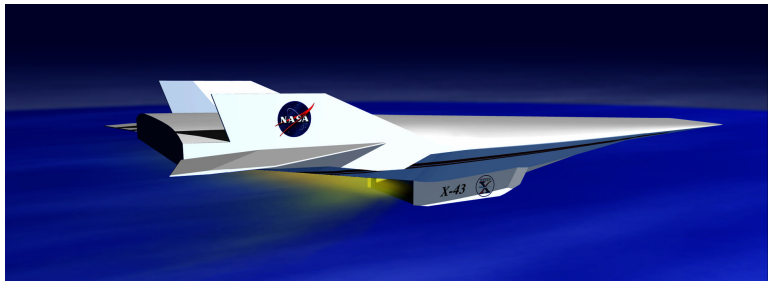
Pursing Parallel Paths

Turbine Based Combined Cycle Ground Demonstration (RTA)

- Development and test of a High Speed Turbine Engine
- Primary element of a Turbine Based Combined Cycle Engine
- Testing in 2006-8
- General Electric selected in July, 2002

Exploring the Future
Advanced Space Transportation Program

Propulsion Flight Demonstrations



X-43A Flight Demonstrator

- Flight validation of a Ma 7 and 10 Hydrogen Ram/Scramjet
- 2nd Flight in late 2003 (Ma 7)
- 3rd Flight TBD (Ma 10)
- Microcraft/Boeing Team

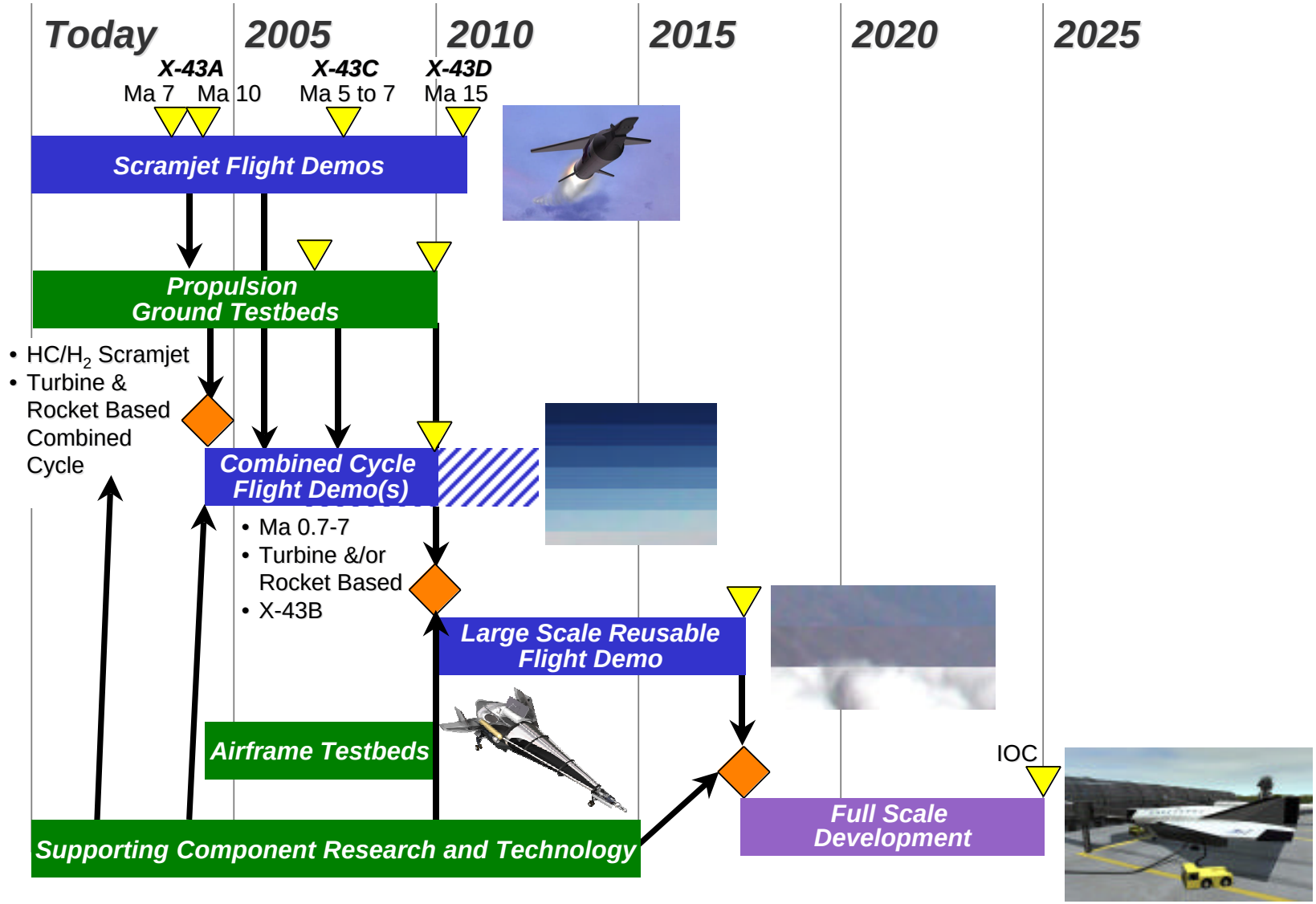
Validation of A Key Element of Any Airbreathing Propulsion System

X-43C Flight Demonstrator

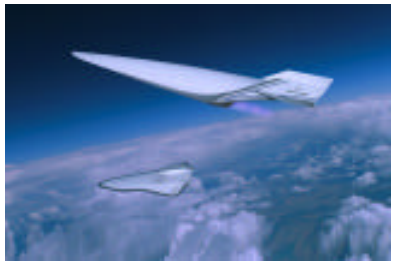
- Flight validation of the USAF HyTECH Hydrocarbon Ram/Scramjet (Ma 5 – 7)
- Integrated with vehicle
- Flights in 2007-8
- Contractor selection in mid-2003

Exploring the Future
Advanced Space Transportation Program

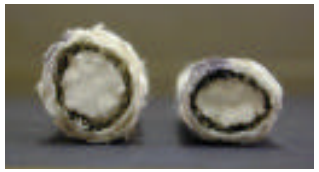
Air Breathing Hypersonics
Access to Space Roadmap

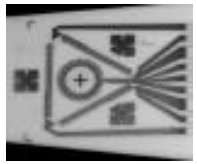


Propulsion R&T Project Objectives

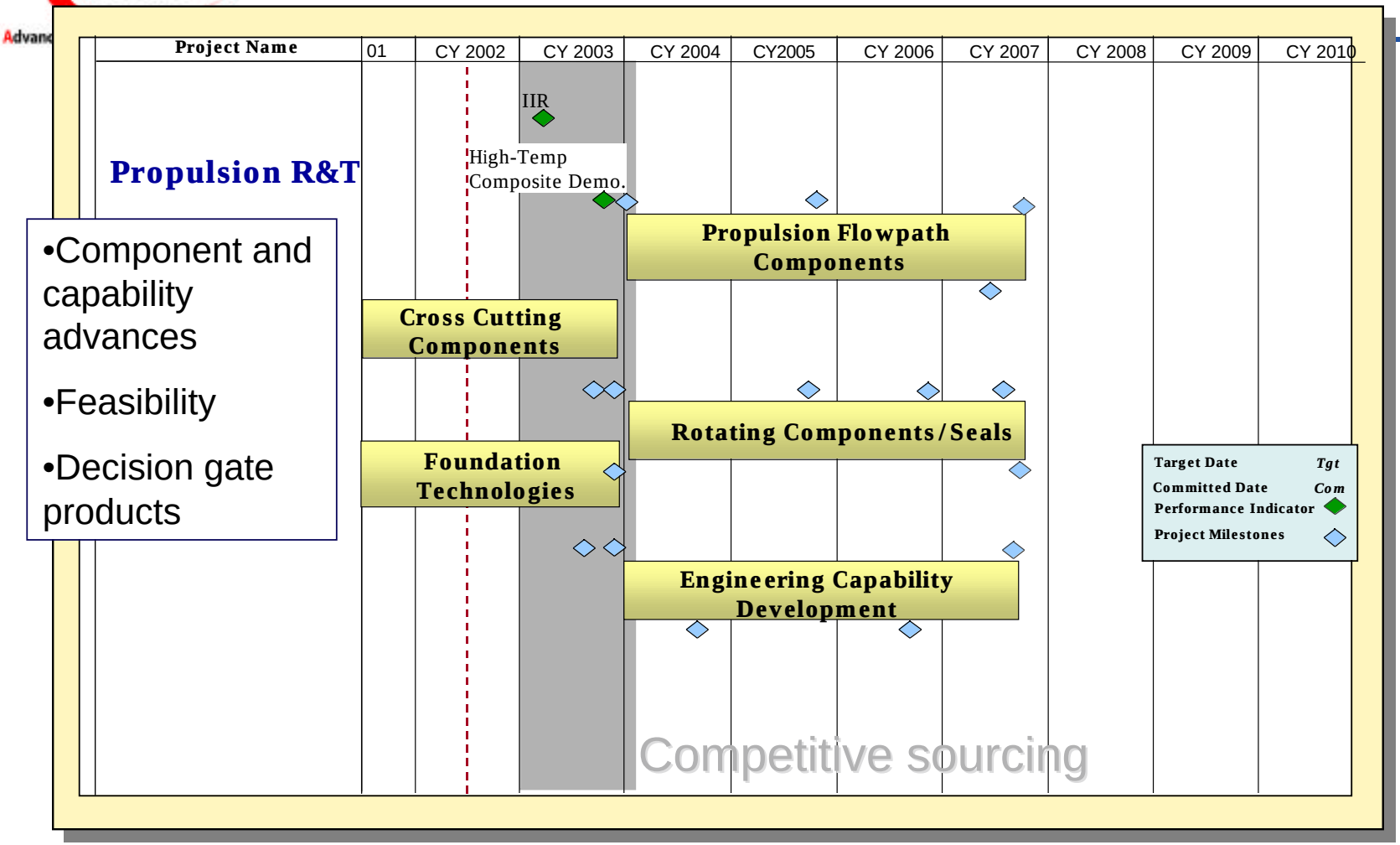


- **FY06 Data Products for Vision Propulsion Design**
  - Technology and Design Advancement
  - Feasibility information
- **Data that feeds FY06 Program Decision Gate(s)**
  - Input for Build 2 definition for Ground Based Demonstrators
  - Identification of technology insertions to flight demonstrators
  - Information for update of program goals, requirements, and vision system design
- **06 Deliverables**
  - Actively cooled panels characterization
  - Rotating component materials
  - High temperature seals
  - Instrumentation





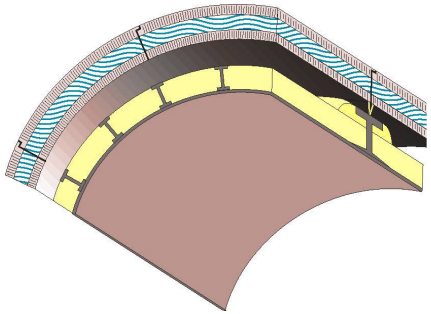
Propulsion R&T Project Elements



Project Overview

- **Airframe project goal**
  - Advance airframe technology providing reduced cost and increased safety through increased performance margin and reusability

- **Performance margin and reusability will be increased by focusing efforts on airframe technical challenges such as**
  - Composite tanks
  - Light weight control surfaces
  - Hot structures
  - TPS
  - Boundary layer transition
  - Transonics
  - Design and analysis tools
  - Sharp leading edges
  - Dynamic seals
  - Health monitoring



- **Customer driven objectives**
  - Increased weight margin
  - Increased combined loads margin
    - Thermal
    - Structural
    - Acoustic
    - Aero/aerothermo
  - Increased operational margin

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Advanced Space Transportation Program

Airframe Project Tasks

- **Integrated Airframe Design**
  - Airframe Health Monitoring
  - Analysis and Design Tools
- **Integrated Thermal Structures and Materials**
  - PMC Constituents and Processes
  - Metallic Hot Structures for Airframe
  - CMC Constituents and Processes
  - Integrated Airframe Structure Development
- **Thermal Protection Systems**
  - Ceramic Acreage TPS
  - Refractory Composite Leading Edges
  - Advanced Control Surface Seals
- **Aerothermodynamics**
  - Rapid Aerothermodynamic Environment Definition
  - Essential Aerothermodynamic Technologies
- **Propulsion Airframe Integration**
  - Scramjet Flowpath Development and Aero-Propulsive Interaction
  - Airframe/Propulsion Aerothermodynamic Technologies

Hypersonics University Research and Engineering Technology Institutes

- URETIs were awarded in August to University of Florida and University of Maryland consortiums

University of Florida

- Principal Investigator: Dr. Wei Shyy
- University Partners
  - Mississippi State University
  - Cornell University
  - Georgia Institute of Technology
  - Syracuse University
  - North Carolina A&T State University
  - Prairie View A&M University

- Propulsion Technologies
- Airframe Technologies
- Vehicle Life Prediction and Health Management
- Systems Integration & Design Optimization
- Educational Program Plan

University of Maryland

- Principal Investigator: Dr. Mark Lewis
- University Partners
  - University of Michigan
  - University of Washington
  - North Carolina A&T State University
  - Johns Hopkins University (APL):

- Mission Analysis
- Cost and Reliability Analysis
- Propulsion
- Aerodynamics/Configuration
- Structures and Materials
- Education Program Plan

Exploring the Future

Advanced Space Transportation Program

The NASA/USAF

X-43C

Seal WBS Linkages

- **Propulsion System - Structural Architecture**
  - Hot Seals for the Propulsion Flowpath
    - Static
    - Dynamic

- **Airframe – Structural Architecture**
  - Airframe and Control Surface Seals
    - Static
    - Dynamic